**Center Innovation Fund: LaRC CIF**

# Drag Reduction by Off-Body Energy Deposition

Completed Technology Project (2017 - 2018)

## Project Introduction

What are the key technical challenges? Implementation of non-equilibrium thermochemistry; Accurate energy balance; Dynamic impulse measurements at Mach 2 What is your approach/research plan? Combined CFD/Experimental investigation; Bench laser deposition data (incident, transmitted power, blast wave expansion rate); Impulse for single energy pulses using model spring-mass system dynamic response. What are the innovative aspects (how is this different than what others are doing in industry, academia government)? Non-equilibrium thermochemistry rather than ideal gas; Full energy accounting for laser energy deposition; Wind tunnel model impulse drag measurements rather than steady state (reduces laser/experimental costs/ and risks)

## Anticipated Benefits

What is the capability need/knowledge gap being addressed? Off-body, pulsed thermal energy deposition using lasers reduces wave drag and sonic boom but lacks definitive assessment of system energy efficiency. What is the state of the art? CFD analysis of the impact of energy deposition on supersonic shock waves and flow fields assumes instantaneous heating modeled by ideal gas behavior. These assumptions fail to predict experimentally observed flow behavior and are suspect for accurate energy efficiency assessments. What are we proposing to do that is unique? The current effort employs a non-equilibrium thermochemistry model for energy deposition in a full Navier-Stokes solver with laser bench-test experimental validation. For system energy assessment, the force impulse and input/output energy parameters for a Mach 2, blunt wind tunnel model will be tested. What is the end goal? The end goal is to make a definitive assessment of the system energy efficiency of pulsed energy deposition for one case to help enable future advanced vehicle concept developments.


Drag Reduction by Off-Body Energy Deposition

## Table of Contents



## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Langley Research Center (LaRC)

**Responsible Program:**

Center Innovation Fund: LaRC CIF

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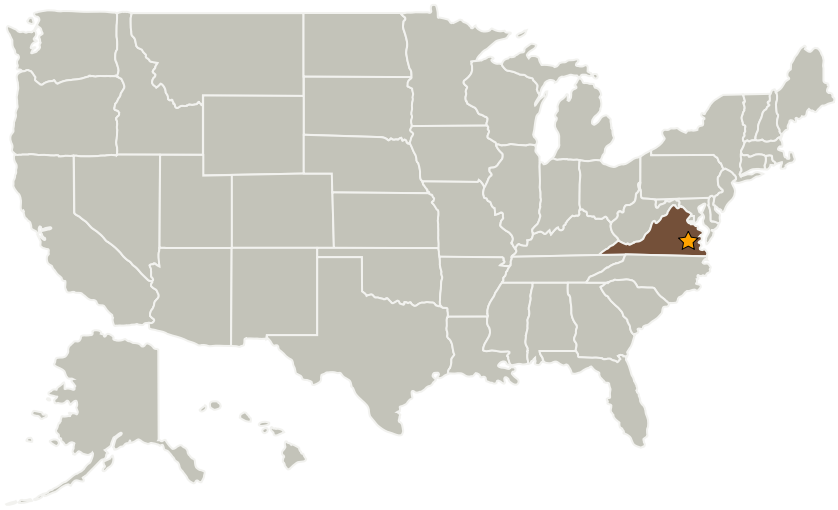
## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| ★Langley Research Center(LaRC) | Lead Organization | NASA Center | Hampton, Virginia |
| Rutgers University-New Brunswick | Supporting Organization | Academia<br>Asian American Native American Pacific Islander (AANAPISI), Hispanic Serving Institutions (HSI) | New Brunswick, New Jersey |

| Primary U.S. Work Locations |
|---|
| Virginia |

## Project Management

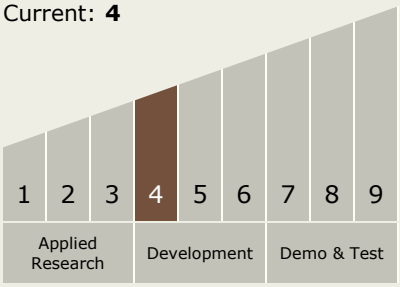
**Program Director:**
Michael R Lapointe

**Program Manager:**
Julie A Williams-byrd

**Principal Investigator:**
Stephen P Wilkinson

## Technology Maturity (TRL)

Start: **4**
Current: **4**




## Technology Areas

**Primary:**

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.8 Warm Gas

## Target Destinations

Earth, Foundational Knowledge